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AN INDUSTRIAL WASTE GUIDE TO THE FRUIT PROCESSING INDUSTRY

Public Health Service
Washington, D. C.

1962

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Fruit Processing Industry

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

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1962

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Fruit Processing Industry

Prepared through cooperation of the National Canners Association and the National Technical Task Committee on Industrial Wastes

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

Division of Water Supply and Pollution Control

Washington 25, D.C.

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Foreword

There is a growing realization that the Nation's water supply is a vital commodity which is not unlimited and whose quality must be protected. Water withdrawn from the community supply must be returned in a condition and by methods which do not result in damage or inconvenience to the community. In recognition of these facts, it is the goal of the canning industry to use or develop methods which will allow discharge of waste waters to streams without causing pollution, to land disposal systems without causing public nuisance, or to community sewerage systems without damage to treatment processes.

The disposal of both liquid and solid waste materials is now a problem of major concern to the canning industry. The net expense for waste disposal is a substantial item in the cost of producing canned foods. It can only be expected that disposal of food wastes will progressively become more troublesome and more costly.

This "Industrial Waste Guide to the Fruit Processing Industry" is intended primarily to provide management and operating personnel in the canning industry a better understanding of the overall problems involved in handling fruit canning waste, and to acquaint them with inplant practices which reduce waste volume and strength. Available methods of waste treatment, pollution prevention and nuisance abatement are discussed. This guide is also intended to acquaint sanitary engineers and regulatory personnel with the sources and nature of fruit canning wastes and with the progress that has been made in treatment of such wastes.

The guide was prepared by Walter A. Mercer and James W. Bell, staff members of the National Canners Association Research Laboratories, who represent the canning industry on the National Technical Task Committee on Industrial Wastes. It was submitted for publication to the Public Health Service through the Task Committee.

The National Technical Task Committee on Industrial Wastes is composed of representatives from the Nation's leading industries concerned with solving difficult industrial waste problems. The objective of the organization is to perform technical tasks pertaining to industrial wastes in cooperation with the Public Health Service and all others concerned with improving the quality of our water resources. The preparation of this guide was one of the tasks assumed by the canning industry in carrying out this objective.

This is the eighth in a series of Industrial Waste Guides prepared by the National Technical Task Committee in cooperation with the Public Health Service.

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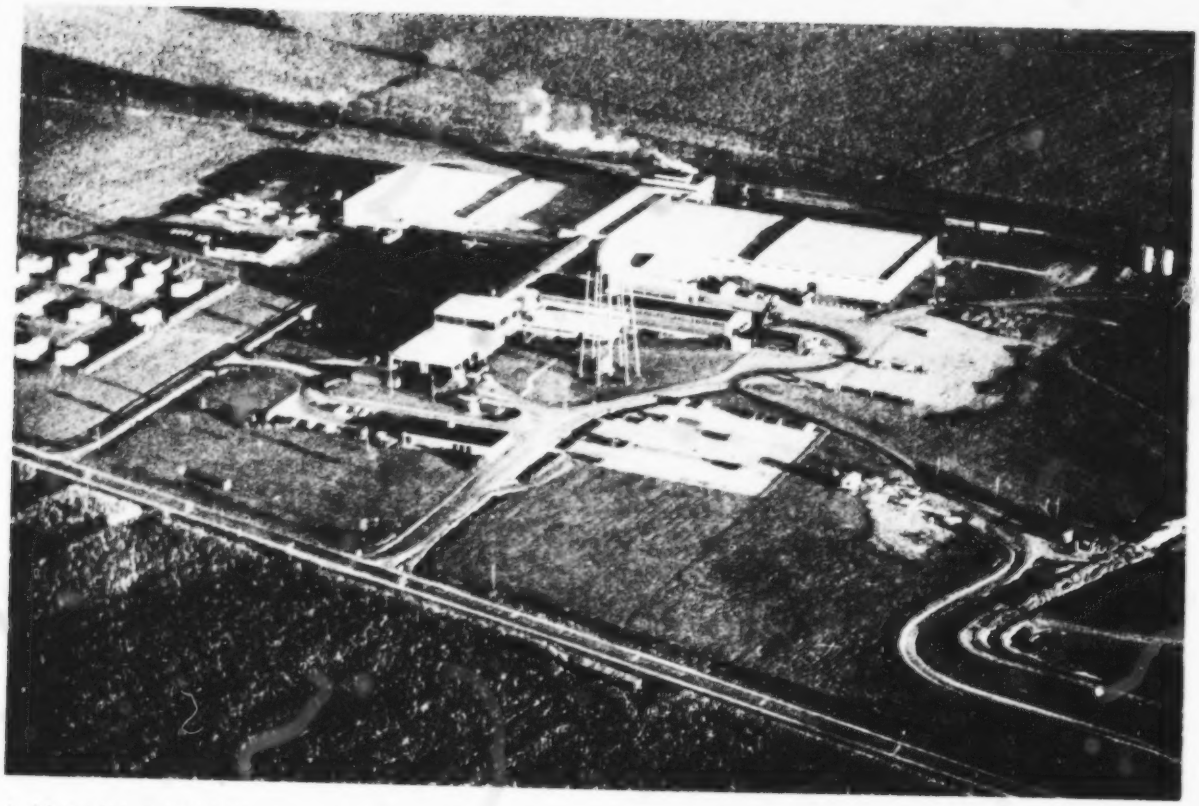

A MODERN CANNERY

an Industrial Waste Guide to the

FRUIT PROCESSING INDUSTRY

Introduction

The Canning Industry has recognized the problems connected with treatment and disposal of wastes from the canning of fruits. It has initiated studies by national and State canning associations and by research groups which sought to establish the technical factors involved in handling and disposing of these liquid wastes by methods which prevent water pollution or other nuisance problems. This publication represents the combined efforts of the many engineers, chemists, bacteriologists, and others who have carried out these studies. It is not the purpose of this publication to present a complete discussion of the many factors involved in treatment and disposal of canning wastes, but to offer a practical guide to cannery management and operating personnel.

It is recognized that individual waste problems may present unique circumstances not considered in this guide. However, experience has shown that all such problems have factors in common. It is the purpose of this guide to discuss the nature and source of the liquid wastes and to describe inplant practices which are known to improve waste disposal situations. The disposal of solid waste materials, consisting of peel, cores, pits, and defective fruit, although the cause of serious difficulties in some areas, does not yet cause water pollution problems as widely distributed as do the liquid portion of the wastes. For this reason it was thought best to devote this guide primarily to problems concerned with disposal of liquid wastes.

Practical procedures are discussed which may reduce the volume and the strength of the waste load and, thus, reduce total waste treatment costs. Water conservation in canning is discussed briefly in connection with its effect on waste problems.

The section on "Methods of Treatment and Disposal" is not intended to be a comprehensive presentation of the knowledge accumulated in this field. The principal methods of treatment generally recognized to be of value are outlined. The selected Bibliography lists references which give detailed information regarding the principles and mechanics of these methods.

Description of Processes

Fruits are received at the cannery in lug boxes or hampers. After dumping on dry belts or into water flumes, the fruits are delivered to preparatory operations which differ depending on the kind of fruit and its intended final form. Such fruits as cherries and plums may be canned whole and unpeeled. Washing, sorting, and trimming of these fruits are the major operations in their preparation for canning.

Other fruits including pears, apples, and peaches must be peeled and cored or pitted in preparation for canning. In the case of pears and apples, mechanical means are generally used to remove the skin and to cut the peeled fruit into halves or slices. Peaches and apricots are halved before peeling and the pit removed. Machines are now widely used in these operations. The halves are belt-conveyed to peelers where they are treated with dilute, hot lye solution. This is applied either by immersion of the fruit in the solution or by spraying it over the halves turned skin-side up on the belt. In either case, the lye is recirculated and maintained at strength by the addition of concentrated sodium hydroxide. At the end of each work shift, the

lye solution is released to the sewer. The heating and recirculating system is then cleaned and recharged with new solution.

After the lye treatment, the fruit halves are subjected to high-pressure water sprays to remove skin and excess lye. Following this wash the fruit is inspected and blemishes removed. Inedible pieces are discarded as waste. After the sorting and trimming operations are completed, the fruit halves may be size-graded and sliced into smaller pieces. The fruit is usually belt conveyed to and from these operations, but hydraulic conveying either by flume or pump is increasing in use. Either means of conveying the fruit requires the use of water which becomes part of the liquid waste to be treated. Belt conveyers must be continuously washed and lubricated with water sprays which contribute to the composite waste flow.

For the final operations, the fruit is conveyed to the canning department where it is given a last inspection and placed into cans or jars. The containers are conveyed to machines which automatically dispense syrup over the fruit. Passage of the cans or jars through a steam-heated box exhausts air from the contents and raises the temperature in order to provide a vacuum in the container after the cover is sealed in place. After heat-processing, the cans or jars are cooled with large volumes of clean water.

Figure 1. Automatic peeling, coring and halving of pears.

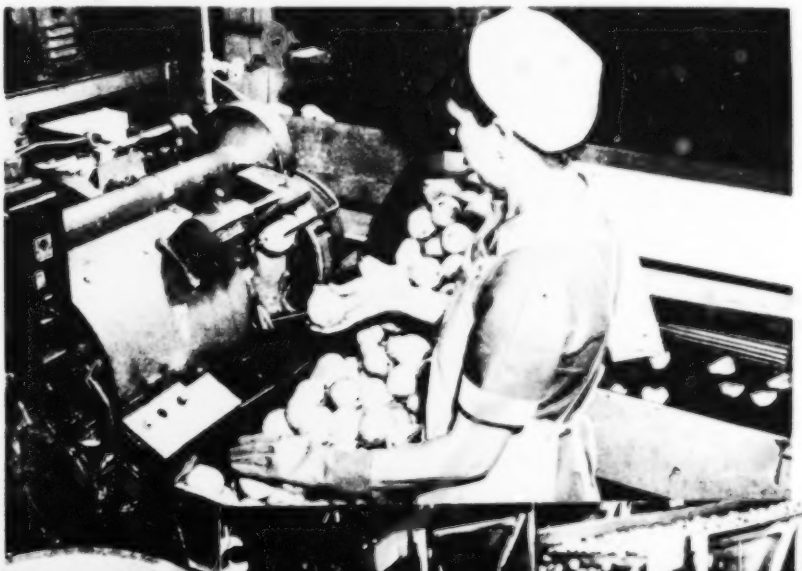

Figure 2. Cutting and pitting of peaches.

Figure 3. Fruit blemishes and inedible portions are removed and discarded as waste.

Sources and Volume of Wastes

Source of Industrial Wastes

Raw, untreated cannery wastes consist of small particles, sometime discarded whole pieces of fruit, peel, cores, and pits, suspended in water which carries in solution the juices of the fruit being canned.

Figure 1 shows pears being fed into machines which automatically peel, core, and halve the fruit. The skins and cores are collected in waste hoppers and removed by truck to a disposal or utilization operation.

In Figure 2, the peaches to be canned are being fed into automatic machines which cut the fruit into halves and remove the pits. Accumulated pits are a part of the solid waste materials for which better means of disposal are needed.

Figure 3 shows inspection after peach halves are lye peeled, then thoroughly washed to remove skin and excess lye. Spent peeling solution and waters used to wash the fruit and conveyor belts become a part of the liquid wastes.

Figure 4 has been prepared to show the usual cannery operations in which both solid and liquid wastes originate. Uniformity of fruit size in the can is obtained by passing the peach halves over vibrating tables perforated with variable-size openings, as shown in figure 5. Surfaces of the tables and fruit are lubricated by water sprays. Juices washed from the fruit contribute much of the soluble organic load to the liquid wastes.

Filling the fruit into cans is a relatively fast, continuous operation often done by automatic machinery as illustrated in figure 6. Syrup or water is added before the cans are closed. The speed of these operations results in some spillage of fruit and syrup which then becomes waste material.

Figure 7 shows filled and closed cans being placed in retorts where they are heat processed to prevent microbial spoilage of the foods. Afterwards the cans must be cooled with clean water.

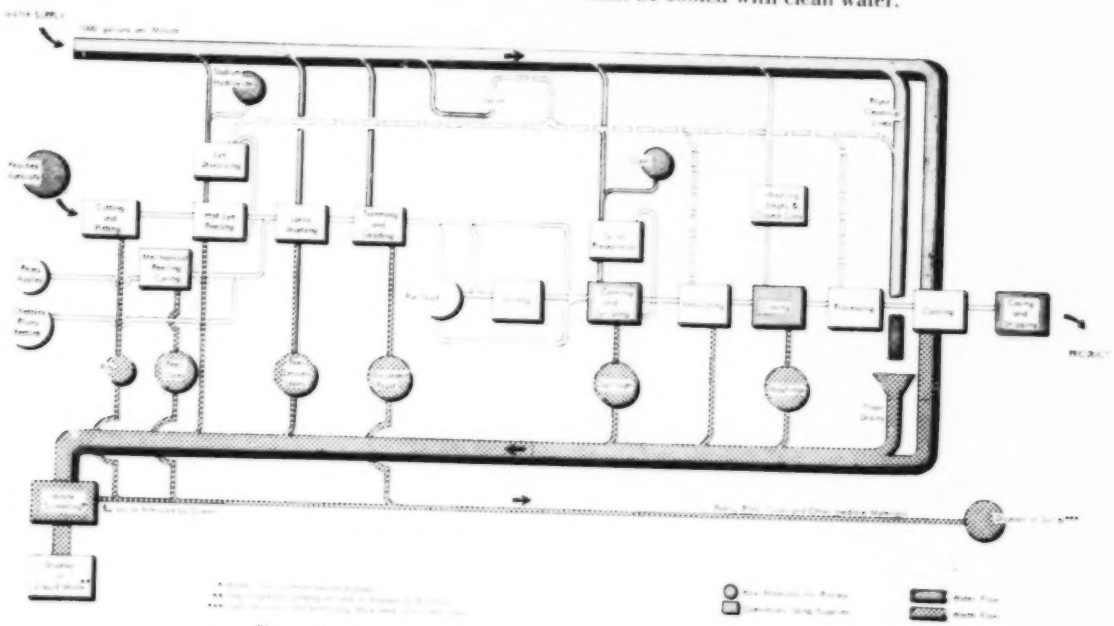

Figure 4. Fruit processing showing water use and sources of waste.

Source of Domestic Wastes

The domestic waste originates in lavatories, locker rooms, and machine shops. Its volume is dependent on the number of employees which must vary widely with the tonnage of fruit being processed.

Volume of Industrial Wastes

Table 1 shows the sources and estimated average volumes of waste waters from the processing steps in the canning of fruits. The volumes given are those which would result if only fresh water is used in all

Table 1. Sources and estimated volumes of waste waters from processing steps in canning of fruits

Operation	Waste flow in gallons		Percent of total flow
	Per hour	Per ton	
Peeling	1,200	48	2
Spray washing	11,000	385	17
Sorting, slicing, etc	3,000	120	5
Exhausting of cans	1,200	48	2
Processing	600	24	1
Cooling cans	24,000	945	37
Plant cleanup	21,000	840	33
Box washing	1,960	70	3

operations and no attempt is made to reuse water. These volumes can be considerably reduced if, for example, can-cooling water is recirculated for cooling, or used for product washing.

Clean water from can washers, can coolers, or evaporative condensers is not considered as waste. If discharged through separate drains to storm sewers and, thence, into streams, it does not cause organic pollution. If this water is added to stronger waste waters which require treatment it may cause hydraulic overloading or other handling problems.

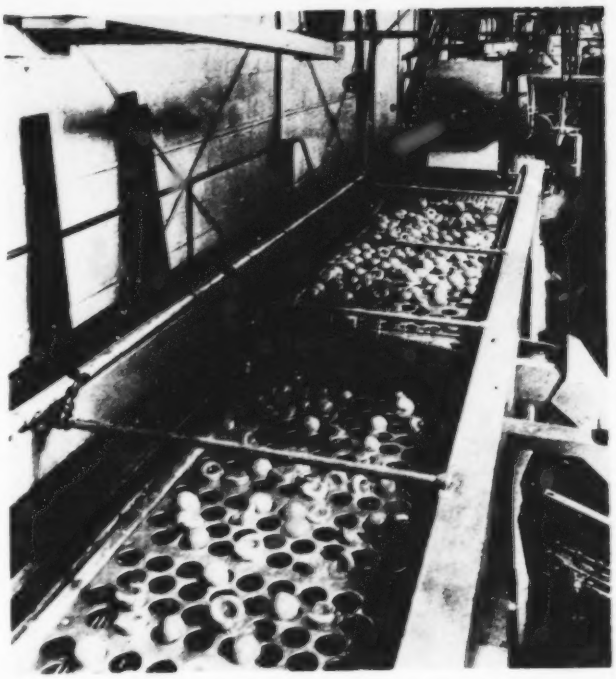

Figure 5. Size grading: clean water sprayed over fruit contributes to waste.

Strength of Wastes

The composite waste flow from a fruit-canning operation contains organic material in two forms, that which is particulate and suspended in the liquid, and that which is soluble and in solution. The suspended solids may consist of peel, pits, cores, and pieces of defective fruit from the trimming tables. Fruit sugars and acids and syrup spillage from the canning operation constitute the dissolved solids in the liquid waste.

Generally it can be assumed that fruit canning produces a liquid waste approximately 10 times the strength of domestic sewage when expressed in terms of biochemical oxygen demand (BOD). Table 2 has

Table 2. Strength of wastes from typical fruit-canning operations

Fruit product	Waste volume	5-day BOD	Suspended solids
	gal./case	*ppm*	*ppm*
Apples	25–40	1,680–5,530	300–600
Apricots	57–80	200–1,020	200–400
Cherries	12–40	700–2,100	200–600
Cranberries	10–20	500–2,250	100–250
Peaches	45–60	1,200–2,800	450–750

been prepared to show more specific information regarding the strength of wastes from the canning of individual fruits. Because of the wide variation in individual canning operations this information should not be relied on in evaluation of an existing waste flow or in designing waste-treatment systems. Each cannery waste problem needs special study. Significant reductions can be made in the strength of fruit canning wastes by institution of waste-saving and waste-prevention practices.

Pollution Effects of Fruit Canning Wastes

When liquid waste from fruit canning is discharged to a stream or other body of water, the ability of the stream to assimilate the waste without showing evidence of pollution will depend largely on the relationship between the volume of waste discharged at a given time and the volume and flow rate of the receiving water. Fruit acids and sugars in the waste stimulate rapid and abundant microbial growth in the stream. Aerobic microbial utilization of the waste requires oxygen which is dissolved in the stream water. The most common and expected pollution effect is depletion of the oxygen supply in the stream to a level at which fish life is killed. If utilization of oxygen is continued without replenishment, anaerobic decomposition of the waste begins with production of odors, discoloration of the stream, and other nuisance conditions.

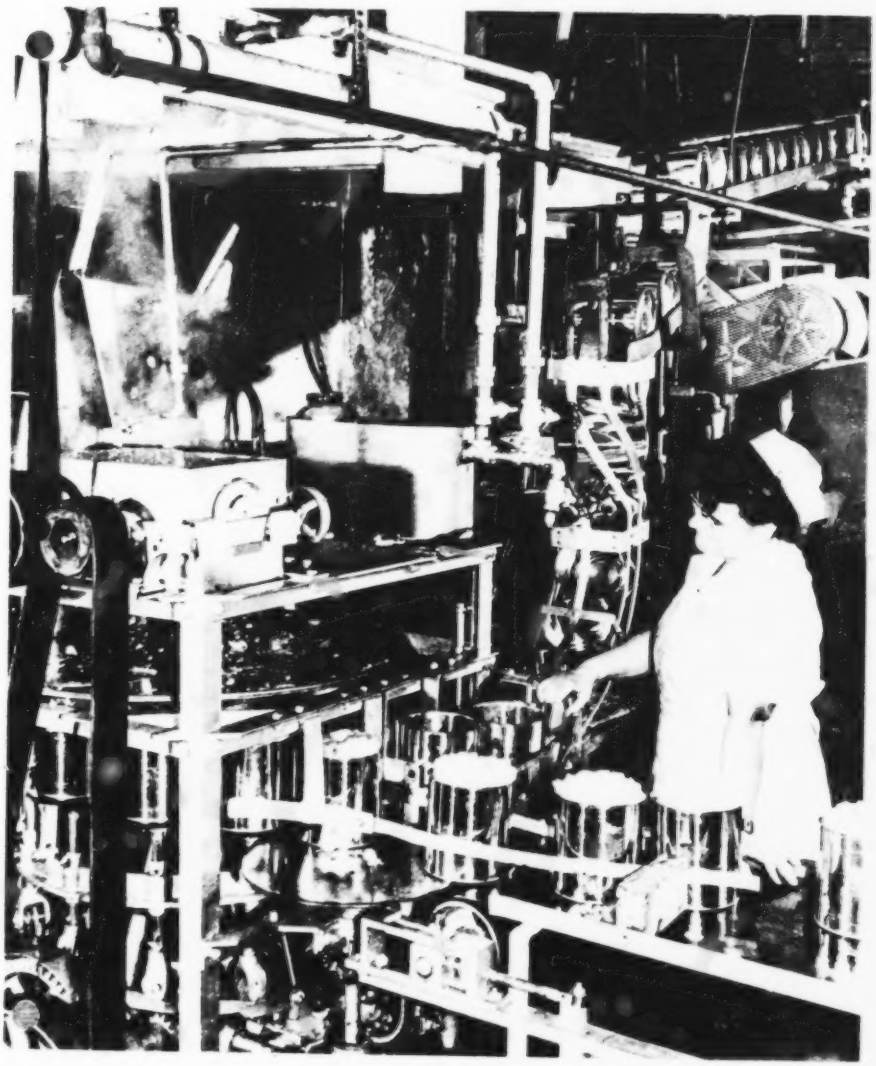

Figure 6.—Can-filling operation; spillage creates waste.

What constitutes stream pollution may differ depending on local and State pollution-control regulations. A number of States have standards for the quality of stream water and the strength of waste effluents which can be legally discharged to streams. In these States industry must meet the standards set-up, regardless of the plant location and regardless of the capacity of the stream to absorb the wastes without unreasonable damage.

Other States have not established uniform standards for waste-effluent strength or stream quality. In this case, each waste discharge situation is evaluated independently, taking into account the type of waste discharged, the assimilative capacity of the stream, and the beneficial uses of the stream.

Pollution control regulations often define three categories of pollution:

1. "Contamination" is the addition to a stream of materials which constitute a health problem. This would include substances harboring living disease-producing bacteria or materials toxic to human life.
2. "Pollution" is the result of adding to a stream materials in a concentration which adversely affects beneficial uses of the water. Destruction of fish life or interference with use of the water for irrigation purposes would be termed pollution.
3. "Nuisance" has the meaning of causing damage to the stream or to property, or inconvenience to the public through unreasonable disposal practices. In this category would be included odor nuisances produced by decomposing wastes or discharge to a stream of highly colored waste waters.

An important fact to be remembered in consideration of fruit-canning waste is that it does not constitute a direct health problem. Unless domestic sewage is added to fruit wastes they do not contain micro-organisms infectious to human beings or animals. The wastes become indirect health factors only if improperly handled.

Waste Prevention and Reduction

The prevention of waste in fruit canning is of considerable economic importance. With the exception of inedible portions of the fruit, any discharge of product to waste is costly, not only because of actual product loss, but also because of the costs involved in providing and operating waste disposal and treatment equipment. Management and supervisory personnel will find it worthwhile to study each canning operation with waste prevention in mind. Appropriate remedial action may increase product yields by preventing excessive waste.

Reuse of Water to Reduce Waste Volume

A study of water usage in a food plant always reveals that more water is used than is necessary, and that the composite waste flow includes clean waters which could be discharged without treatment. Any reduction in the volume of waste flow is a saving in disposal and treatment costs. Often trouble in sewage-treatment plants receiving cannery wastes is the result of hydraulic overloading and not the organic strength of the wastes. When liquid wastes are discharged to a land disposal system, such as oxidation ponds, a reduction in volume means extended retention time in a given storage area and, consequently, a higher degree of waste stabilization.

Reuse of water is an effective means of reducing the volume of liquid waste. Several basic procedures for conserving water can be used in all canneries. These involve the elimination of waste through use of automatic shutoff valves on water hoses, use of high-pressure sprays for cleanup rather than low-pressure sprays, and elimination of excessive overflow from soaking and washing tanks. Significant savings of water can be accomplished by substitution of mechanical conveyors for water flumes, and the selection of equipment more efficient in design and operation.

In a typical fruit-canning operation the largest single use of water is that required to cool the heat-processed cans. Where water shortage is not a problem, the cooling water should be separated from the composite waste flow. It may then be discharged without treatment to storm sewers or other means of disposal.

Where segregation and separate disposal of the cooling water is not possible, it should be reused as a

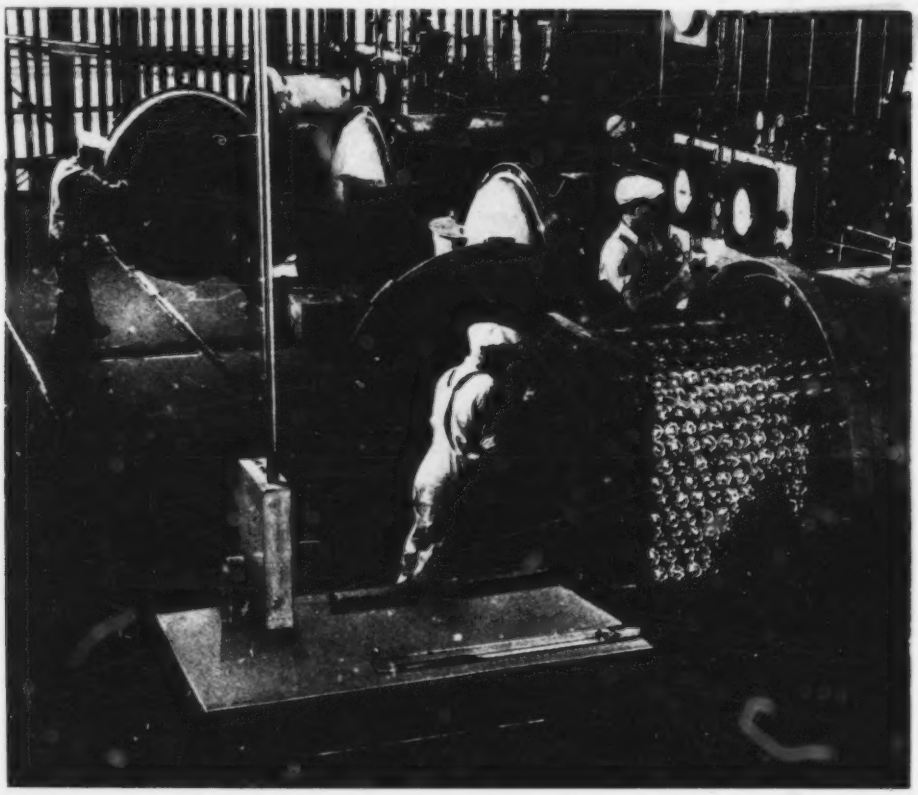

Figure 7. Filled and closed cans are placed in retorts where they are heat processed.

means of reducing the volume of liquid waste. The most efficient method of reuse, after cooling and chlorinating the water, is recirculation for can cooling.

When can-cooling water is not recirculated, it may be considered for reuse in the following operations:

1. In caustic or water peeling baths.
2. For removal of caustic after peeling.
3. As a primary wash of the raw fruit.
4. For canning belt lubrication.
5. For plant cleanup operations.

Methods of Treatment and Disposal

In consideration of treatment and disposal of fruit canning wastes, one of three objectives must be accomplished: (1) the wastes must be made suitable for discharge to a stream without causing pollution; (2) a land disposal system must be set-up which will not result in nuisance problems due to excessive odor production; or, (3) the wastes will be discharged to a sewage treatment system. Local conditions and circumstances will dictate prescribed treatment and disposal practices. However, certain procedures are in general use throughout the Nation. It is the purpose here to outline general procedures and methods used by the canning industry.

Removal of Gross Solids by Screening

Whatever the method of final disposal may be, the suspended solids should be removed by screening the composite waste flow. Failure to screen the waste may cause: (1) unsightly conditions in streams because of floating solid materials which may form scum blankets or bottom sludge; (2) unnecessary overload on oxidation ponds or digesters, if this type of treatment is used; or, (3) clogging of sewerlines, filters, and distributors if discharge is to a sewage treatment plant. Screening is required by most pollution control measures. Intentional grinding or comminuting of solids, to pass them through a regulation screen, is not allowed.

Types of Mechanical Screens

Rotary Drum Screens. A screen type in general use for solids removal is the rotary drum screen. It is essentially a revolving drum covered with a screen cloth which varies in fineness from 10 to 20 openings per inch. The liquid and solid wastes enter through an open end. The solids are retained on the inside of the cloth and are washed from the cloth by water sprays as the drum passes over a refuse trough. In other drum screens the solids are conveyed from the drum by a spiral flange in the drum.

In the usual screen installation, the screen is mounted over a sump in which the screened liquid is collected for removal by pump. The solids are conveyed from the screen by screw or bucket elevator and collected in a hopper for eventual dumping into a truck.

Vibrating Table Screens. Now widely used are table-type vibrating screens which receive the waste at one end slightly elevated to pass the solid material down to a conveyor under the bottom edge of the screen. Liquid passing through the screen is collected in a sump beneath. With this type screen, it is possible to use a cloth with smaller openings. The amplitude of the back-and-forth vibration can be adjusted for different waste materials. A 4- by 8-foot size screen of this type will handle 800 to 1,000 gallons of waste per minute.

Gyrating Screens. Circular screens having a gyratory motion are used in some cannery installations. While these screens were designed for dry-screening and are widely used for separating sand, gravel, grains, and other products, they show promise for wet-screening operations. Among the advantages claimed for these screens are: (1) special foundation or support is not required; (2) unscreened materials do not flood over; and (3) the three-way vibration allows use of finer screen cloths.

Disposal of Solid Wastes

Generally, the waste solids from canning are a liability to the canner. Often, however, thought and ingenuity can lessen the costs of their disposal. Sometimes a canner is able to arrange for the solid refuse to be hauled away for animal feed and its value as feed is usually considered payment for the hauling. Also, disposal may be by spreading over farmland, or removing to drying beds from which it is later piled and burned. In some urban areas canners have to pay on a tonnage basis to have the solids removed. In these instances it is desirable to have the waste as dry as possible. Vibrating-type screens give drier solids than revolving drum screens. Elevation of the solids to a hopper facilitates loading into trucks and allows considerable dewatering during storage in the hopper.

In some cases cannery waste solids have been successfully turned into dehydrated stockfeed. Other attempts have turned fruit wastes into ensilage. Production of alcohol from fruit solids is technically possible. Economic factors have limited attempts to utilize the wastes.

Disposal of Screened-Liquid Wastes

The final volume of screened-liquid waste which reaches the point of discharge should be as small as possible consistent with sanitary canning operations.

In some areas certain types of screened-liquid wastes are discharged without further treatment. Usually, however, some additional treatment must be given. The most common methods are as follows:

1. Discharge to municipal sewage-treatment systems.
2. Biological treatment.
3. Impounding in earthen tanks for purposes of soil absorption or stabilization by oxidation.
4. Land irrigation.

Need for Equalization Tank

Whatever the method of final treatment, it is desirable to collect the screened wastes in an equalization tank before treatment. Passage of the wastes through such a tank will furnish emergency storage in case of equipment failure, make possible a uniform flow to the disposal area or treatment plant, and allow blending of the fluctuating organic or chemical composition of the wastes. In the equalization tank, provision should be made for sludge removal and, if possible, aeration by some means to prevent septic conditions and odor production.

Discharge to a Municipal Sewage-Treatment Plant

Discharge of screened raw cannery wastes into a municipal sewage-treatment plant is the most desirable disposal method if satisfactory arrangements can be made. However, the seasonal nature of cannery operations and the high-pollutional strength of the wastes may cause serious problems. The nature of the pol-

lutants in the cannery waste may also upset normal sewage treatment processes. The sugars and sugar-like compounds in liquid wastes from fruit canning require a biological process for stabilization which is not desirable for the complete stabilization of domestic sewage. In some phases of stabilization the two are directly antagonistic. It has been observed that in cases where the volume of domestic sewage is not large enough to give high dilution of the cannery waste, attempts to treat the combined wastes are not effective. However, many canners are discharging wastes to large municipal systems where treatment is completely satisfactory.

In contemplating the discharge of cannery waste to a municipal system the following factors should be considered by both canner and municipality:

The type of treatment process used by the sewage plant. Activated sludge treatment processes are reported to be particularly adversely affected by cannery waste in high concentration.

The volume of cannery waste. The relationship between the volume of cannery waste and the volume of domestic sewage should be considered: that is, whether or not dilution of the cannery waste will be high enough to prevent harm to the treatment process.

The capacity of the sewage plant. The seasonal production of cannery wastes means that consideration must be given to the costs of increasing plant capacity for short-time treatment in relation to the costs of other methods of treatment and disposal.

The type and cost of pretreatment of the cannery waste. In nearly all cases screening of the cannery waste is necessary, and in many cases pH adjustment of the cannery waste is required before its discharge to the sewer.

The charges which the canner must pay. The charges to the canner for the privilege of discharging his wastes to the municipal treatment system are usually based on one or more of the following considerations:

1. *No charge.* In some municipal areas, authorities and citizens encourage industry because of the employment provided and the disbursement of money through salaries and purchases.
2. *Initial payment.* An outright purchase of the privilege of waste-disposal services may be based on the cost of new equipment required to treat the cannery wastes with no further service charges thereafter.
3. *Annual charge for waste-disposal services.* The charge for service may be the annual payment of a fixed sum which is usually an estimate of the additional expense incurred by the sewage plant in treating cannery wastes.
4. *Charges based on water consumption.* This basis for charge is probably the one most commonly used. It may be assumed that the amount of water metered into the plant is the amount of water discharged. However, a considerable volume of water is lost through evaporation or addition to the finished product, so a compensating reduction should be allowed.

   The charge to the canner may be only that which he pays for the water. If a separate charge is made for disposal services the canner may find it profitable to meter the waste water. In some instances clean waters discharged to the sewer, such as cooling and condenser waters, are measured and the volume excluded from disposal charges. Ordinarily, disposal charges are calculated on the basis of each 1,000-gallons discharged, or rate schedule of diminishing charge for increasing volume may be used.

Biological Methods of Treatment

Screened liquid-cannery waste is amenable to treatment by biological methods, and high degrees of reduction in the strength of the waste can be obtained. However, treatment depending on biological oxidation should be attempted only after investigation of other methods and after careful consideration of the problems involved.

Biological methods are most suitable for treating small volumes of cannery waste. Where a small volume of strong waste can be segregated from the total flow, its treatment by biological methods can give a great reduction in the strength of the composite flow. For example, in fruit canning the peeling operation contributes only 2 to 5 percent of the total volume of waste, yet removal of the spent caustic reduces the strength of the total waste by 50 to 60 percent.

All types of fruit-canning wastes will support the growth of bacteria which utilize the sugars and other carbohydrates present. The fermentation of these compounds occurs very quickly and the end-products of the fermentation are compounds of much lower pollutional strength.

Both anaerobic and aerobic digestion of cannery waste have been experimented with, and successful

large scale operations have been carried out with each type of digestion. Anaerobic digestion (digestion in the absence of free oxygen) requires more elaborate equipment and more careful attention. For these reasons it may be feasible only in selected cases.

Aerobic digestion of organic wastes is more easily carried out. Usually a two-stage process is planned. In the first stage the fresh screened waste is admitted to a tank where air is continuously diffused into it. This supplies the free oxygen required by the aerobic bacteria in their biochemical action on the organic compounds. The wastes may be detained and aerated in a batch-type or continuous flow operation. The efficiency of the process depends on building up in the aeration-digestion tank a vigorous culture of suitable bacteria. Conditions in the tank must be controlled to prevent inhibition of their growth. Good diffusion of air throughout the tank must be maintained continuously. The pH of the waste must be held within a suitable range for growth of the bacteria. Certain types of wastes may require the addition of small amounts of available nitrogen as a food supplement for the bacteria.

In the second stage of the process the waste passes through sedimentation tanks where the flow is made as quiescent as possible in order to promote either flotation or settling of suspended solids.

Disposal to Absorption Ponds and Storage Lagoons

Impounding cannery wastes in storage lagoons offers a means of disposal which eliminates stream pollution and may be less expensive than other methods of treatment. A lagoon is used at the cannery shown in the frontispiece (lower right corner). Storage of liquid wastes in earthen ponds allows partial or complete decomposition of the waste, after which the waters can be discharged by controlled flow to a watercourse or to a municipal plant for further treatment. Where soil conditions are favorable, complete absorption into the soil may be obtained.

The lagooning-disposal method requires a land area large enough to hold the volume of waste and one that is situated within a distance practical for pumping or piping the wastes. The drainage characteristics of the soil should be studied. Seepage of waste waters should not contaminate underground sources of water supply. Also of importance is the proximity of residential areas. Untreated lagoons develop odors which may cause complaint from people living within a radius of a mile, or more, under certain conditions.

Odor Control in Cannery-Waste Lagoons

As an aid in the prevention of offensive odors from lagooned wastes the lagoon itself should be as large and shallow as the situation will permit. Septic conditions quickly develop in deep lagoons. A waste depth of not more than 3 feet is preferred, and 5 feet is the maximum. The growth of weeds and grass should not be permitted in lagoons. Since they are of organic composition, their presence in the lagoon contributes to the odor problem.

In the presence of free oxygen, the starches and sugars of cannery wastes are changed by bacterial action into stable inoffensive compounds such as water, carbon dioxide, nitrates and sulfates. When oxygen is exhausted from the wastes, anaerobic bacteria continue the decomposition with the production of foul-smelling gases such as hydrogen sulfide, ammonia, and mercaptans. This anaerobic condition in lagoons will occur quickly unless fresh waste is continuously added or available oxygen is supplied by other means.

The most satisfactory method for odor control in lagoons is the addition of nitrate of soda, which supplies the available oxygen required for inoffensive decomposition of the wastes. Sodium nitrate of the fertilizer grade is added daily to the fresh waste going into a lagoon in an amount necessary to satisfy 20 percent of the 5-day BOD.

Disposal by Spray Irrigation

In recent years spray irrigation has been used increasingly as a means of cannery-waste disposal, as shown in figures 8 and 9. In many respects it is an improvement over other methods. It consists of spreading the liquid waste over the surface of the ground by means of a high-pressure sprinkler system. A rate of application is used which produces only minimum damage to vegetative growth and avoids surface erosion and runoff. The system usually requires the following items:

A mechanically operated screening unit.

A collecting tank for accumulation of screened waste.

Stationary screens to prevent clogging of the outlet from the tank.

A pump which develops the required nozzle pressure.

A main line for transporting waste to the irrigation site.

Lateral lines for distribution from the main line.

Self-activated revolving sprinklers.

The land on which to spray.

An actively growing cover crop to aid in absorption and to prevent soil erosion.

With the proper equipment and controlled application of the waste, spray irrigation will completely prevent stream pollution, will not create odor problems, and is usually less expensive than other methods of waste disposal.

Selection of the irrigation site. Of major importance in this method of waste disposal is the selection of land for the irrigation site. Its location must be within practical pumping distance of the cannery. Consideration should be given to the economics of pumping long distances as compared to the costs of disposal by other means.

The topography of the land and characteristics of the soil are important factors to consider. Spray irrigation of land which is not fairly level may not be successful because of runoff and erosion. The possibility of stream pollution from runoff should be considered. Depressions in the surface of the land may cause ponding of the waste water, with odor production resulting from its decomposition.

The amount of land required to dispose of a given volume of waste is determined by the absorption characteristics of the soil, which are, therefore, an important factor in the success of spray irrigation. At present there is no reliable method of predetermining this. Persons having a knowledge of local soil conditions should be consulted.

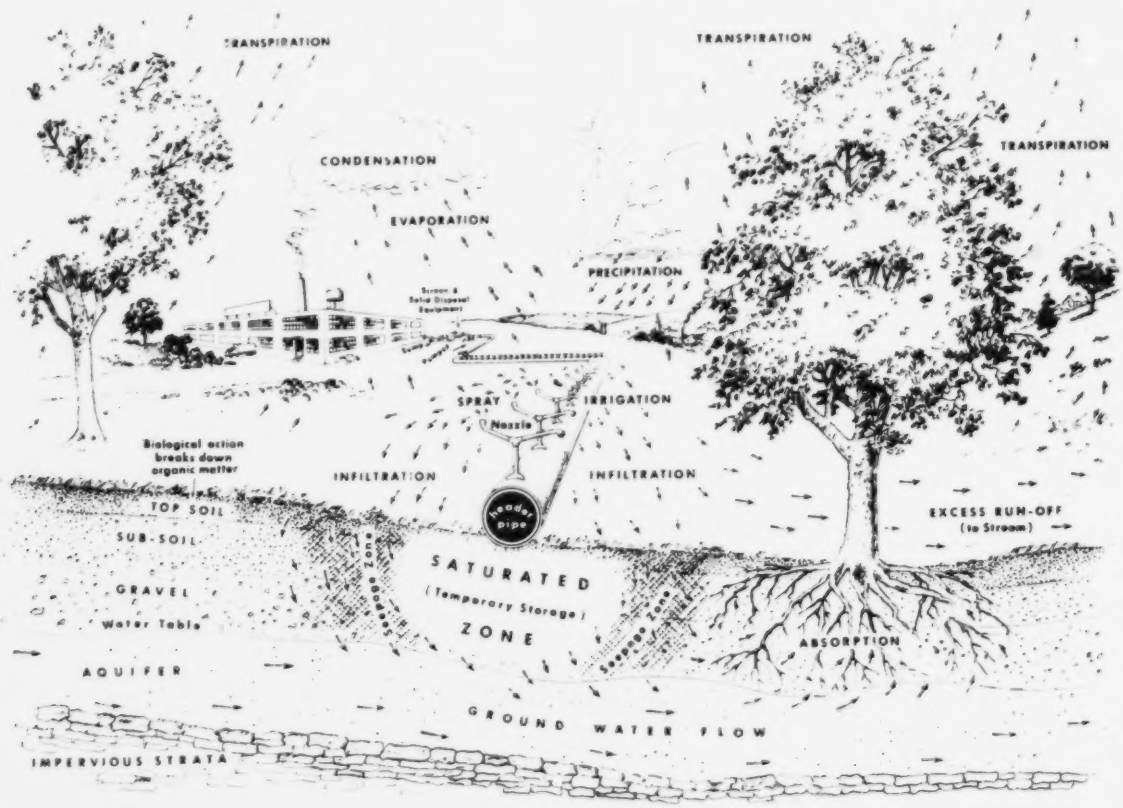

Figure 8. Cannery waste disposal by screening and spray irrigation.

Figure 9. Spray irrigation disposal of cannery wastes.

Importance of the cover crop. When screened raw wastes are sprayed over land without a vegetative cover crop, the rate of application is governed by the rate at which the land will physically absorb the waste. Waste runoff and soil erosion are always serious problems. The importance of a cover crop on irrigated land is quickly apparent when the rates of waste application with and without a cover are compared. For land without a cover crop the amount of waste absorbed is only about 10 to 15 percent of the amount which could be disposed of with a cover crop on the land.

The type of vegetative cover may be determined by what the land is to be used for either during or after the canning season. At some installations cattle are grazed on the vegetative growth during spray operations. The cutting of hay from the land is also common practice. One cover-crop mixture frequently used includes the following:

	Pounds
Mammoth clover	3
Ladino-Alsac mixture	4
Alta fescue	4
Redtop	3
Orchard grass	2

This mixture is sowed at the rate of 16 pounds per acre. As dense a cover crop as possible should be provided at the time spraying is to start.

Other considerations. Failure to properly screen cannery wastes is frequently the cause of difficulty in the operation of a spray-irrigation system, because the presence of gross solids results in plugging of the spray nozzles. The screen cloth used should not be so fine as to cause flooding over of unscreened wastes. A thorough screening with a coarser cloth would be preferable. Finely divided solids can be sprayed without trouble.

If odors are to be avoided in spray irrigating, the canaery waste must be applied to the land while still fresh. This is a factor to consider in constructing the collecting tank or sump. A tank which has a capacity to provide a long-detention time can be a disadvantage since fermentation of the waste will occur. Odors may then be a problem and the lower pH of the waste may cause unnecessary damage to the cover crop. Ordinarily the detention time should not be more than 3 to 4 hours.

Sampling and Analysis of Wastes

An important item of information about a waste effluent is its organic strength and potential pollutional effect. This information, combined with flow rates, can be used as a basis for the following:

1. Determination of the organic load discharged to a treatment plant.
2. Collection of data on which to base sewer-rate charges.
3. Design of treatment and disposal systems.
4. Measurement of treatment efficiency and effectiveness.
5. Detection and measurement of stream pollution.

Sampling Waste Waters

The varying conditions under which waste samples will be collected in a food cannery prevent the giving of detailed instructions, but sampling procedures can be considered generally, leaving special problems to be solved as they arise.

Grab samples. Two types of waste samples may be taken for analysis, namely, grab and composite samples. Grab samples serve as convenient spot checks. They are analyzed separately, and are not mixed with other samples. The samples are obtained by dipping the waste from tanks, gutters, or other containers. The analytical results from a grab sample are of limited

value unless a series of samples is taken in the same way at the same point. A series of grab samples is useful in showing the changes in solids concentration or other physical characteristics due to changes in plant operation.

Composite samples. A composite sample consists of measured portions of the waste water collected at frequent regular intervals to show average conditions in the waste over a period of time. If the rate of waste discharge is fairly constant, a composite sample may be made-up of individual samples of the same volume. If the rate of waste discharge varies, a weighted composite sample is of more value. In this case, the rate of waste flow must be known. The aliquots constituting the composite sample should be proportional in volume to the rate of waste flow at the time the sample is collected. For example, if the rate of flow at one sampling time is 500 gallons per minute (g.p.m.) the sample could be 50 ml. or some multiple of this amount. If the rate of flow increased later to 1,000 g.p.m., the sample at that time should be 100 ml.

Type of Sample for a Specific Test

The type of sample, whether grab or composite, most appropriate for a specific test will be determined by the stability of the constituent to be tested for, and the accuracy desired in the results. With this in mind, each specific test can be listed under the type of sample most suitable for its determination. Below are listed the determinations for which each type of sample is most appropriately used.

Grab Sample	*Composite Sample*
pH	Biochemical oxygen demand
Total acidity	Chemical oxygen demand
Total alkalinity	Total solids
Dissolved oxygen	Suspended solids
Settleable solids	Dissolved solids
Chlorine residual	

Preservation of the Samples

Since it is often necessary that samples be transported to outside laboratories for analysis, consideration should be given to preservation of the samples. Most cannery wastes are relatively unstable. Bacterial growth and chemical reactions can bring about significant changes in a short time. The rate of change is influenced by temperature, pH, and concentration of organic matter. Any attempt to inhibit bacterial growth by the addition of bactericidal agents may hasten chemical changes, or alter some physical characteristics of the waste. Immediate analysis is the best insurance against significant errors in running grab samples. However, since composite samples may need to be stored for as long as 24 hours, some means of preservation must be used. Refrigeration at a temperature of 36°–40° F. is the best and most common method. This retards bacterial growth and slows chemical and physical changes. Samples stored for only a short time at room temperature may be 10- to 40-percent lower in BOD than fresh waste. Chemical preservatives such as chloroform have been used to prevent bacterial growth, but these do not retard chemical and physical changes. Chemical preservatives must not be used in samples reserved for BOD determinations.

In instances where delayed BOD determinations are desirable, the waste water may be preserved by canning and heat processing in the following manner: Samples of the wastes which are representative, as regards the concentration of solids, are filled into cans which are, preferably, but not necessarily, enamel-lined. A headspace of one-half inch is allowed. The cans are processed for 25 minutes at 240° F., or the equivalent, and water-cooled. The processing does not affect the BOD value.

Procedures for Analytical Methods

Procedures for the methods of analysis discussed here can be found in "Standard Methods for the Examination of Water, Sewage, and Industrial Wastes", 10th Edition, published by the American Public Health Association, Inc., 1790 Broadway, New York 19, N.Y.

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